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Protection of Healthcare Workers Against COVID-19 at a Large Teaching Hospital in Seoul, Korea

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Thirteen patients with coronavirus disease 2019 (COVID-19) visited a university hospital in Seoul before recognizing their disease infections, causing contact with 184 hospital workers. We classified the patients into four risk levels and provided corresponding management measures. At 31 days after the last event, all screening laboratory results were negative, and no symptoms/signs were reported.

Key Words: COVID-19, SARS-CoV-2, health personnel, cross infection

South Korea's past experiences with Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS) have made us aware of the importance of protecting healthcare workers from the start of the current coronavirus disease 2019 (COVID-19) crisis.[1,2] During this period of pandemic, it is more crucial to maintain the sustainability of medical resources by preventing healthcare workers from infection. However, it became seemingly impossible to maintain even the minimal level of sustainability, as the number of COVID-19 cases have increased explosively and reached the maximum capacity of the healthcare system.[3] Amid continued struggles to stop the spread of COVID-19 in South Korea, private healthcare sectors have established prevention strategies according to the guidelines provided by the Korea Centers for Disease Control and Prevention (KCDC).[4] Here, we report on the results of 184 hospital employees who experienced in-hospital contact with COVID-19 patients before they were officially confirmed with infection at a university hospital in Seoul, Korea.

We analyzed anonymized data from Severance Hospital, which has about 2400 beds and over 10000 outpatients daily (IRB Approval No. Y-2020-0020). Thirteen cases of COVID-19 visited the hospital a few days before their confirmation with the disease, between February 29 and March 27, 2020. For each case, the Department of Infection Control conducted in-hospital epidemiological investigation by interviewing the patients and searching hospital information system and CCTV records, and then identified 184 hospital employees who had possible contact with the cases. The employees were classified into four risk levels according to the epidemiologic investigation team's instruction for management of those who were possibly exposed to COVID-19. Initially, the instruction was developed based on the KCDC's guidelines,[4] and then it was modified by the opinions of medical professionals in the COVID-19 infection control task force team. The task force team consisted of the hospital director, vice directors, members of the Department of Infection Control, infectious disease specialists, preventive medicine specialists, emergency medicine specialists, respiratory disease specialists, pediatric disease specialists, laboratory medicine specialists, executive members of the Division of Nursing, and administrative executives. Depending on the level classified, the employees having possible contacts

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Table 1. Risk Classification and Management Plan for Healthcare Workers in Possible Contact with COVID-19 Patients

Risk level	Management plan	Possible contact	Protection of healthcare workers
3	Self-quarantine*	Close contact with a COVID-19 patient not wearing face mask Aerosol-generating procedures¶ Direct physical contact‖	Without four-item-set of PPE‡‡ Without four-item-set of PPE‡‡ Without four-item-set of PPE‡‡
2	Active monitoring†	Contact within 2 meters in closed space Contact within 2 meters in open space	Not wearing respirator§§ Not wearing respirator or face mask¶¶
1	Passive monitoring‡	Minimal contact**	Not wearing respirator
0	Usual management§	Any types of contact No possibility of close contact††	With four-item-set of PPE‡‡ Not applicable

COVID-19, coronavirus disease 2019; PPE, personal protective equipment; RT-PCR, reverse transcription-polymerase chain reaction.
*Daily checklist of COVID-19 related symptom/signs; RT-PCR virus tests on day 1 and day 14; self-quarantine for 14 days, †Daily checklist of COVID-19 related symptom/signs; RT-PCR virus tests on day 1 and day 14, ‡Self-monitoring for COVID-19 related symptom/signs; single time RT-PCR virus test, §Routine screening at the same level as other hospital staff; RT-PCR virus tests upon request, ¶Including open suctioning of respiratory tract, intubation, bronchoscopy, and cardiopulmonary resuscitation. ‖Including vital sign check-up, blood sampling, potential contact with patient's body fluid, and therapies requiring physical contact, **Brief or distant (>2 m) contact with a COVID-19 patient while wearing face masks, ††No possibility of close contact, but working in the same department when a COVID-19 patient visits, ‡‡Personal protective equipment consisting of gloves, long-sleeved gowns, eye protection, and fit-tested respirator, §§N95/KF94 (certified by Korea Food & Drug Administration, which filters at least 94% of 0.4 μm-sized particles) or equivalent, ¶¶Surgical/dental mask or equivalent.

Table 2. Classification of Healthcare Workers who Came in Contact with COVID-19 Patients

Variables	Total (n=184)	Risk level			
		Level 0 (n=145)	Level 1 (n=17)	Level 2 (n=9)	Level 3 (n=13)
Age (yr), median [min-max]	28 [21–66]	28 [22–66]	37 [21–58]	29 [23–41]	27 [24–56]
Sex					
Male	58 (31.5)	43 (29.7)	7 (41.2)	4 (44.4)	4 (30.8)
Female	126 (68.5)	102 (70.3)	10 (58.8)	5 (55.6)	9 (69.2)
Occupation					
Physicians	32 (17.4)	27 (18.6)	2 (11.8)	-	3 (23.1)
Nurses	60 (32.6)	50 (34.5)	4 (23.5)	-	6 (46.2)
Therapists	45 (24.5)	40 (27.6)	-	5 (55.6)	-
Radiologic technologists	11 (6.0)	9 (6.2)	2 (11.8)	-	-
Hospital porters	11 (6.0)	9 (6.2)	1 (5.9)	-	1 (7.7)
Hospital administrators	5 (2.7)	2 (1.4)	3 (17.6)	-	-
Maintenance workers	3 (1.6)	2 (1.4)	-	-	1 (7.7)
Security guards	13 (7.1)	5 (3.4)	3 (17.6)	3 (33.3)	2 (15.4)
Others*	4 (2.2)	1 (0.7)	2 (11.8)	1 (11.1)	-
Face mask/respirator					
N95/KF94†	92 (50.0)	80 (55.2)	2 (11.8)	4 (44.4)	6 (46.2)
Dental	61 (33.2)	35 (24.1)	15 (88.2)	5 (55.6)	6 (46.2)
Not equipped	2 (1.1)	1 (0.7)	-	-	1 (7.7)
Undetermined	29 (15.8)	29 (20.0)	-	-	-
Site of exposure					
Emergency room	80 (43.5)	69 (47.6)	-	4 (44.4)	7 (53.8)
Inpatient wards	6 (3.3)	-	-	-	6 (46.2)
Outpatient clinics	21 (11.4)	16 (11)	5 (29.4)	-	-
COVID-19 screening center	19 (10.3)	17 (11.7)	2 (11.8)	-	-
Rehabilitation center	45 (24.5)	40 (27.6)	-	5 (55.6)	-
Others	13 (7.1)	3 (2.1)	10 (58.8)	-	-
Number of RT-PCR test‡					
Twice	47 (25.5)	26 (17.9)§	-	9 (100.0)	12 (92.3)
Once	79 (42.9)	62 (42.8)§	16 (94.1)	-	1 (7.7)
None	58 (31.5)	57 (39.3)	1 (5.9)	-	-

COVID-19, coronavirus disease 2019; RT-PCR, reverse transcription-polymerase chain reaction.
Values are number (%), if not indicated otherwise.
*Including medical technicians in the emergency room, ambulance drivers, in-hospital pharmacists, and convenience store cashiers, †KF94 is a respirator certified by Korea Food & Drug Administration, which filters at least 94% of 0.4 μm-sized particles, ‡RT-PCR virus tests for SARS-CoV-2 on nasopharyngeal swab; all results were negative, §RT-PCR virus tests were performed upon request for a part of the group.

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with the COVID-19 cases were subject to the SARS-CoV-2 virus test using reverse transcription-polymerase chain reaction (RT-PCR) on a nasopharyngeal swab or monitoring for COVID-19-related symptoms/signs (Table 1).

The majority of the 184 hospital employees were nurses (32.6%), therapists (24.5%), and doctors (17.4%). We confirmed that most of them (83.2%) were wearing face masks/respirators; however, information on 29 people's respiratory protection were unclear due to the lack of CCTV monitoring inside the hospital rooms. Risk classification resulted in 145 (78.8%), 17 (9.2%), 9 (4.9%), and 13 (7.1%) cases for Level 0, 1, 2 and 3, respectively. In Level 3, a relative high-risk group, there were many nurses (46.2%) and doctors (23.1%); and staffs working at the emergency room (53.8%) and inpatient wards (46.2%). A total of 126 RT-PCR virus tests (twice for everyone at Levels 2 and 3, except for one person who retired before the 14th day) were performed, and all test results were negative (Table 2). No COVID-19 related symptoms/signs were reported until April 27, 2020, which was the 58th day since the first COVID-19 case's visiting and the 31st day since the last.

A large number of healthcare workers were protected from COVID-19, despite their possible contact with COVID-19 patients before confirmation.

In-hospital transmission can lead to a shortage of medical staff and even partial/complete closure of the hospital, resulting in serious loss of the already-deficient medical resources. As the first in-hospital cluster infection in South Korea, an 800-bed university hospital, located in northwest Seoul, had temporarily closed its entire outpatient service, including the emergency room, for 17 days.[5] Since the two community-acquired COVID-19 cases had no high-risk epidemiologic history or distinguished symptoms, the diagnosis was delayed while two hospital workers were infected, followed by 10 additional transmissions to families and co-workers. Two other large hospitals also had been shut down due to nosocomial COVID-19 transmission in other areas as well.[6,7] The sudden hospital closures not only decreased the healthcare resources offered by the venues, but also hindered the capacity of other regional facilities by transferring the admitted patients.[5-8]

After a sudden increase of COVID-19 transmissions in mid-February, the KCDC encouraged hospitals to step up monitoring of all visitors.[4] People without face masks were not allowed into most hospitals, and those with suspicious symptoms and possible exposure history were forced to visit COVID-19 test centers. Hospitals emphasized hand sanitization and respiratory protection for employees and patients. In addition to these measures, our hospital conducted immediate epidemiological investigation when a new infection was discovered, identified people who were at risk of exposure, and tested and monitored such cases according to the risk classification. One of the nosocomial transmission cases at a large hospital in South Korea led to the infection of 17 hospital workers, including physicians and nurses, in 22 days;[9] and the transmission is suspected to have started from an unidentified asymptomatic case.[8] Fortunately, there was no COVID-19 transmission to employees in our hospital, despite the 13 asymptomatic patients visiting our premises with various contacts with hospital workers. We believe that our preventive strategies might help reduce the risk of in-hospital transmission, which would minimize the loss of healthcare resources. It is urgent to establish more efficient strategies to protect our valuable but insufficient healthcare workers and facilities.

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AUTHOR CONTRIBUTIONS

Conceptualization: all authors. Data curation: Yong Woo Jeon and Yeon Kim. Investigation: all authors. Resources: Eun Suk Park, Yeon Kim, and Jun Yong Choi. Supervision: Jun Yong Choi and Hyeon Chang Kim. Validation: Eun Suk Park and Jun Yong Choi. Visualization: Yong Woo Jeon and Hyeon Chang Kim. Writing—original draft: Yong Woo Jeon and Eun Suk Park. Writing—review & editing: Yong Woo Jeon, Eun Suk Park, Sun Jae Jung, Jun Yong Choi, and Hyeon Chang Kim. Approval of final manuscript: all authors.

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